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journal homepage: www.elsevier.com/locate/fgcsModeling affective character network for story analytics[☆]

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HIGHLIGHTS

- The paper presents a novel model and methods for analyzing stories of narrative works.
- The proposed methods are focusing on detecting affective events described in the stories.
- The affective events are detected by temporal changes of tensions per flows of the stories.
- The tensions are measured by affective relationships among characters appeared in the stories.
- It has shown its efficiency on recommendation system for the narrative works.

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ABSTRACT

Consideration of the stories included in the narrative works is important for analyzing and providing narrative works (e.g., movies, novels, and comics) to users. In this study, we analyzed the stories in a narrative work with three goals: (i) eliciting, (ii) modeling, and (iii) utilizing the stories. Based upon our previous studies regarding 'character networks' (i.e., social networks among characters in the stories), we elicited the stories with three methods: (i) composing affective character networks with affective relationships among the characters, (ii) measuring temporal changes in tension according to the flows of the stories, and (iii) detecting affective events which refer to dramatic changes in the tension. The affective relationships contain emotional changes of the characters on each segment of the stories. By aggregating the characters' emotional changes, we measured the tension of each segment. We called it 'Affective Fluctuation' and represented it as a discrete function (Affective Fluctuation Function, AFF). The AFFs enable us to detect affective events by using gradients of them and measure similarities among the stories by comparing their shapes. Also, we proposed a computational model of the stories by annotating the affective events and characters involved in those events. Finally, we demonstrated a practical application with a recommendation method which exploited the similarities between stories. Additionally, we verified the reliabilities and efficiencies of the proposed method for narrative works in the real world.

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1. Introduction

With the advent of smart devices and extension of web accessibility, a massive amount of narrative works (i.e., artworks which involve storytellings) in various formats (e.g., TV series, short film, and transmedia) is distributed through diverse media (e.g., film, TV, book, online streaming, etc.). Narrative works contain stories that consist of three components: characters, events, and backgrounds. It causes many challenges for content providing services (e.g., retrieval, recommendation, and curation services)

that address narrative works (e.g., movies, novels, comics, graphic novels, animations, etc.). One of the major issues is that the existing content analysis methods have difficulty reflecting the contents of the narrative works, since the narrative works are humanistic items which are manufactured, analyzed, and consumed by human beings.

To address this issue, various approaches have been attempted. The simplest solution is to apply external data which are manually annotated by humans (e.g., meta-data, tags, etc.) [1]. One of the representative attempts of this approach is Netflix.¹ The Netflix's recommender engine is highly dependent on multiple and detailed tags which are manually attached to the narrative works [2]. In order to implement a large amount of tags, Netflix has hired

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¹ <https://www.netflix.com/>.

employees to specifically be Netflix taggers.² It is indisputable that small and middle-sized businesses would have difficulty affording the same method as Netflix. As such, the demand for an automated analysis method for the contents of narrative works exists.

There have been attempts to affectively analyze narrative works [3]. Some of them have been focused not on the affective features within the narrative works, but rather on the reactions of users. Users' reactions have been used for an approach that inversely connects the affective characteristics of the narrative works from the emotional states of the users who used the narrative works based on their physiological reactions like EMG (ElectroMyoGraphy), ECG (ElectroCardioGram), and more [4,5]. Other approaches have attempted to extract the affective features from the physical characteristics of the narrative works (e.g., beats of sounds, brightness of colors, etc.) [6,7]. However, it also cannot ascertain the contents of narrative works in a majority of the stories.

Different than the former two approaches, a few studies have attempted to analyze the stories of the narrative works directly by applying SNA (Social Network Analysis) methods and partially using NLP (Natural Language Processing) [8,9] and image processing [10,11] methods. These methods, which is referred to as character networks, compose the social networks among the characters within the narrative works and analyze them with SNA techniques. The character network is meaningful in terms of enabling the use of sufficiently verified techniques in a SNA domain. Nevertheless, these studies also have the following limitations: (i) dependencies on media, domains, and formats and (ii) difficulties reflecting the affective features of the stories. First, generalization of the World Wide Web (WWW) and personal smart devices causes the appearances of novel media like web comics or web drama, which can include particular physical features that limits the use and reuse of these types of methods. Although the character network is independent of the physical features, the existing studies have limited their applicable area by their data collection methods. Furthermore, the character network is only reflecting how frequently the characters are interacting, which makes it difficult to outline stories that represent sequences of events that occurred among the characters. Changes in the characters' interactions can be the result of the events, however, they do not directly represent the events.

To deal with this challenge, we proposed a novel SNA-based content analysis method for narrative works. It is based on an affective character network which is an extension of the former SNA-based methods: character network, dynamic character network, and more. The affective character network is developed by attaching affective relationships among the characters that appear in the narrative works. By observing changes in both affective and social relationships among the characters, we measured the fluctuations of tensions expressed in the narrative works according to the flows of the stories, and detected affective events that made the tensions heighten. Finally, we modeled the stories by using the detected affective events and transitions of the characters between them.

Furthermore, in order to prove utility and efficiency of the affective character network and the proposed story model, we proposed a similarity measurement among the stories of the narrative works. Similarity was estimated by the sequences of the affective events and temporal changes of the tensions. In addition, in order to utilize the similarity measurement, we suggested a preliminary story-based recommender system. The recommendation method is composed on the basis of the conventional item clustering-based collaborative filtering (ICCF) algorithm. We applied the story-based similarity measurement for clustering the narrative works.

The contributions of this study can be categorized, as follows:

1. Novel representation of the affective relationships among the characters that appeared in the narrative works and the temporal changes of the affective relationships (Section 3.2.1),
2. Method to measure the tensions within the stories and detect the affective events from the temporal changes of the tensions (Section 3.2.2),
3. Computational model of the story which displays the sequence of affective events within the narrative works and the transitions of the characters among them (Section 3.3), and,
4. Story-based recommender system based on a story-based similarity measurement (Section 4).

The remainder of this paper is organized in the following manners. In Section 2, we describe the raising problem and introduce the definition of the affective character network and how it is extended from the character network and the dynamic character network. Also, we present a conceptual design of the story model based on the affective character network. In Section 3, the proposed representation for the affective relationships among the characters is depicted with the methods for exposing the affective relationships among the characters. Also, we introduce the measurement of the tensions according to the flows of the stories and depict the detection of the affective events from the temporal changes in the tension. Furthermore, we represent the proposed model of the stories with the detected affective events. In Section 4, we describe the method for measuring the similarities among the narrative works by using the affective character network and the proposed story model. Moreover, we introduce a simple method to recommend the narrative works on the basis of the story-based similarity measurement. In Section 5, we evaluate the efficiency and reliability of the affective character network, the story model, the story-based similarity measurement, and the story-based recommender system. Finally, we present related studies with a focus on the content analysis methods in Section 6, and then in Section 7, we conclude our work and present a direction for future studies.

2. Problem description

To deal with narrative works that are distributed through various media, the content providing services require automated content analysis methods which are independent from domains, formats, and media. Although various methods have been proposed to improve it, most of them are focused on the physical features of the narrative works which are mainly visual or audible [12–14]. These methods are not only dependent on formats and media, but also has an obvious limitation of a gap between the low level physical features and high level semantics [15–17,6,3]. In this section, we extended and re-defined character networks, which was introduced in our previous studies [10,11,18,19], to achieve two main purposes: (i) represent the stories of the narrative works and (ii) minimize its dependencies on domains, formats, and media.

First, we newly define the character network which is a social network among characters that appear in the narrative works. Previous studies [20,8,11] have commonly defined and composed the character networks as dependent on various data sources, including the co-occurrences of the characters, dialogues, and more. Nevertheless, they demonstrated how strongly arbitrary that two characters are connected. To reduce the dependencies and emphasize the significance, which is the social relationships among the characters, we generalized the concepts of the character networks, as follows.

² <https://www.washingtonpost.com/news/arts-and-entertainment/wp/2015/06/11/netflix-tagging-yes-its-a-real-job>.

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